PATENT

IN THE U.S. PATENT AND TRADEMARK OFFICE

Appellants:	Claus Erdmann FURST et al.
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Examiner:	Xu Mei
For:	MICROPHONE UNIT WITH INTERNAL A/D CONVERTER
Atty. Dkt. No.:	45900-000664/US
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401 Dulany Street
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August 28, 2007

APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. §41.37

Sir:

Appellants submit herewith their Brief on Appeal as required by 37 C.F.R. § 41.37 along with the appropriate governmental fees as required by 37 C.F.R. §41.20(b)(2).

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BRIEF ON BEHALF OF APPELLANTS

Appellants hereby provide the following remarks in support of the Notice of Appeal filed on June 22, 2007, appealing the Examiner's final rejection of claims 1, 5, 7, 17, 18, 36 and 38 of the present application in the Office Action (hereinafter "Action") mailed on March 8, 2007. A listing of the appealed claims 1, 5, 7, 17, 18, 36 and 38 is provided in the *Claims Appendix*.

I. REAL PARTY IN INTEREST

The real party in interest is Techtronic A/S as evidenced by the Assignment recorded at Reel 012448 and Frame 0036.

II. RELATED APPEALS AND INTERFERENCES

Appellants' legal representative is aware of no appeals or interferences that will directly effect, be directly effected by, or have any bearing on the Board's decision in the Appeal.

III. STATUS OF CLAIMS

Claims 1, 5, 7, 17, 18, 36 and 38 are pending in the current application with claim 1 being written in independent form.

Claims 1, 5, 7, 17, 18, 36 and 38 remain finally rejected under 35 U.S.C. § 103(a) as being unpatentable over Martin, U.S. Patent No. 5,796,848 in view of Arndt et al. (hereinafter "Arndt"), U.S. Patent No. 6,421,448.

The final rejection to claims 1, 5, 7, 17, 18, 36 and 38 is being appealed. A listing of appealed claims 1, 5, 7, 17, 18, 36 and 38 is provided in the attached *Claims Appendix*.

IV. STATUS OF AMENDMENTS

Appellants submit that no amendments were submitted in the Appellants' Response Under 37 C.F.R. §1.116 filed on May 8, 2007, which was entered on the record as indicated in the Advisory Action mailed on June 4, 2007. Appellants submit that no amendments have been filed after the Notice of Appeal filed on June 22, 2007.

V. SUMMARY OF CLAIMED SUBJECT MATTER

Independent claim 1 recites a microphone assembly including a microphone assembly casing having a sound inlet port, a transducer for receiving acoustic waves through the sound inlet port, and for converting received acoustic waves to analog audio signals, said transducer being positioned within the microphone assembly casing, an electronic circuit positioned within the microphone assembly casing, said electronic circuit comprising a signal path defined by a cascade of a pre-amplifier for amplifying analog audio signals from the transducer, and a sigma-delta modulator for providing digital audio signals, wherein the microphone assembly further comprises filter means in the signal path between the pre-amplifier and the sigma-delta modulator, the filter means preventing low frequency components from reaching the sigma-delta modulator.

Example embodiments provide a microphone assembly including a high-pass filter connected between microphone pre-amplifier and A/D converter, which preferably is a sigma-delta modulator.[1] The high-pass filter blocks DC components in the signals between microphone pre-amplifier and A/D converter.[2] The high-pass filter also reduces the overall noise level in the microphone assembly by filtering out low frequencies.[3] An additional amplifier (not shown) may be connected between high-pass filter and A/D converter.[4] This additional amplifier may be a buffer or a differential converter, such as a single-ended to differential converter.[5]

According to other example embodiments, a low-pass filter (not shown) may be connected between pre-amplifier and A/D converter.[6] This low-pass filter prevents undesired aliasing effects by limiting the frequency content of the signals before they are provided to A/D converter.[7] High-pass filter and low-pass filter are preferably incorporated into the microphone pre-amplifier 110 though, alternatively, high-pass filter and low-pass filter may optionally be separate from the microphone pre-amplifier.[8] The digital output signals on a line are preferably raw signals in the sense that they have not been formatted according to any

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[1] Specification, p. 9, ll. 26-28.
[2] Specification, p. 9, ll. 28-30.
[3] Specification, p. 9, ll. 30-31.
[4] Specification, p. 9, ll. 31-32.
[5] Specification, p. 9, ll. 32-34.
[6] Specification, p. 10, ll. 1-2.
[7] Specification, p. 10, ll. 2-3.
[8] Specification, p. 10, ll. 3-6.

standard audio format.[9] The preferred raw digital output signals on another line are transmitted to the pure digital DSP for further digital processing.[10]

The high-pass filter typically includes a capacitor and a resistor.[11] The filtering effect of high-pass filter is minimized by selecting capacitor and resistor values making τ as large as possible, or in other words, ensure a very low cut-off frequency of the high-pass filter.[12] Furthermore, it is essential to minimize the noise from the high-pass filter itself.[13] This may be achieved by selecting as large capacitance (*e.g.,* 8 μF) as practical since the electronic noise from a capacitor is given by kT/C, where C is the capacitance, T is the temperature and k Planck's constant.[14] It is clear that the electronic noise from the capacitor increases with a smaller capacitance.[15]

The characteristics of high-pass filter may be designed by taking into consideration the design of the transducer receiving the acoustic signals.[16] For example, by introducing a small pressure equalization opening in the flexible diaphragm of the transducer, the cut-off frequency of the acoustic high-pass filter may be lowered down to, for example, 50 Hz.[17] With such a low cut-off frequency, the high-pass filter may be designed with a smaller capacitor without increasing the total noise from the microphone.[18] However, it may still necessary to remove frequencies below 200 Hz electronically so as to avoid overloading the microphone.[19] For this reason high-pass filter may advantageously be designed with a cut-off frequency of around 200 Hz.[20] Following this approach, the acoustic noise from the microphone is minimized.[21] Noise leaking the acoustic high-pass filter may be filtered out by high-pass filter.[22] Removal of the lower frequencies electronically using high-pass filter results in a lower total noise and better matching of the low cut-off frequency.[23]

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[9] Specification, p. 10, ll. 6-7.
[10] Specification, p. 10, ll. 7-9.
[11] Specification, p. 10, l. 12.
[12] Specification, p. 10, ll. 12-15.
[13] Specification, p. 10, l. 15.
[14] Specification, p. 10, ll. 15-18.
[15] Specification, p. 10, ll. 18-19.
[16] Specification, p. 10, ll. 21-22.
[17] Specification, p. 10, ll. 22-24.
[18] Specification, p. 10, ll. 24-26.
[19] Specification, p. 10, ll. 26-27.
[20] Specification, p. 10, ll. 28-29.
[21] Specification, p. 10, l. 29.
[22] Specification, p. 10, l. 30.
[23] Specification, p. 10, ll. 30-32

The immediate result achieved following the above-mentioned design route is that the physical dimensions the capacitor may be significantly reduced which also means that the overall size of the microphone assembly may be reduced.[24] This size issue is of specific importance in the area of hearing aids.[25]

An alternative microphone assembly includes a microphone casing that includes transducer, a microphone pre-amplifier, an A/D converter, and a digital filter in accordance with other example embodiments.[26] The A/D converter is preferably a sigma-delta modulator, and the microphone pre-amplifier may optionally include either a high-pass filter or a low-pass filter or both.[27] The digital filter removes the high frequency noise from the digital bit stream.[28] For example, the digital filter is preferably a digital decimation low-pass filter, which removes out-of-band quantization noise.[29] The digital filter may be incorporated in a pure digital DSP outside the microphone casing.[30] Whether the digital filter is incorporated in the A/D converter or in the pure digital DSP will depend on size constraints, for example.[31]

Example embodiments provide a microphone assembly with a formatting circuit connected between an A/D converter and a pure digital DSP.[32] The formatting circuit formats the signals from the A/D converter in accordance with a digital audio standard, such as, for example, S/PDIF, AES/EBU, I^2S, or any other suitable digital audio standard.[33] Alternatively, the formatting may be performed by the pure digital DSP.[34] The formatting circuit is preferably incorporated into the A/D converter within a microphone casing, and may further include a digital filter.[35] The pre-amplifier may optionally include a high-pass filter and/or a low-pass filter.[36] The formatted digital output signals may be transmitted on a line to the pure digital DSP for further processing or, because the digital output signals are formatted according to a digital audio standard, may be plugged into or incorporated directly

[24] Specification, p. 10, l. 34 – p. 11, l. 1.
[25] Specification, p. 11, ll. 1-2.
[26] Specification, p. 11, ll. 4-7.
[27] Specification, p. 11, ll. 7-9.
[28] Specification, p. 11, ll. 9-10.
[29] Specification, p. 11, ll. 10-12.
[30] Specification, p. 11, ll. 12-14.
[31] Specification, p. 11, ll. 15-16.
[32] Specification, p. 11, ll. 18-20.
[33] Specification, p. 11, ll. 20-22.
[34] Specification, p. 11, ll. 22-23.
[35] Specification, p. 11, ll. 23-25.
[36] Specification, p. 11, ll. 25-27.

into a device which is compliant with such digital audio standard, such as a portable audio or video device, for example.[37]

Example embodiments also provide a microphone assembly having an integrated circuit (IC) connected between transducer and a pure digital DSP.[38] The IC is located within a microphone assembly casing and includes a microphone pre-amplifier and an A/D converter, which is preferably a sigma-delta modulator.[39] Depending on the application, the IC may further include any one or combination of the following components: the high-pass filter, the low-pass filter, the additional amplifier, the digital filter, or the formatting circuit.[40] Size constraints of the microphone may dictate how many additional components are incorporated on the IC.[41] The analog audio signals from transducer are provided to the IC which outputs either raw or formatted digital output signals on a line to the pure digital DSP.[42]

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

Appellants seeks the Board's review of the rejection of claims 1, 5, 7, 17, 18, 36 and 38 under 35 U.S.C. § 103(a) as being unpatentable over Martin in view of Arndt.

VII. ARGUMENTS

Appellants submit that claims 1, 5, 7, 17, 18, 36 and 38 are allowable for features present in each claim. Appellants submits that the claims are argued in one group including claims 1, 5, 7, 17, 18, 36 and 38, which rise and fall together, with claim 1 being representative.

A. INDEPENDENT CLAIM 1

In view of the following arguments, Appellants submit that Martin in view of Arndt, as relied upon by the Examiner, fails to teach, or suggest, a microphone assembly including a "filter means in the signal path between the pre-amplifier and the sigma-delta modulator, the

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[37] Specification, p. 11, ll. 27-31.
[38] Specification, p. 11, ll. 33-34.
[39] Specification, p. 11, l. 34 – p. 12, l. 1.
[40] Specification, p. 12, ll. 1-5.
[41] Specification, p. 12, ll. 5-6.
[42] Specification, p. 12, ll. 6-8.

filter means preventing low frequency components from reaching the sigma-delta modulator" as recited in independent claim 1.

Namely, the Examiner acknowledges that "Martin does not disclose the microphone assembly further comprises filter means in the signal path between the pre-amplifier and the sigma-delta modulator to prevent low frequency components from reaching the sigma-delta modulator."[43] The Examiner then relies on Arndt to cure the deficiencies of Martin. However, Appellants submit that the combination of Martin and Arndt is improper for the following reasons.

i. Function of Arndt's High-Pass Filter and Microphone

Referencing column 2, line 39-42, the Examiner asserts Arndt teaches that "[t]he small hole(s) in the membrane of the microphone(s) [disclosed] by Arndt is used to cause the shift of each of the microphones (3, 3', 30, 30') to reach its limit frequency, which is about 100 Hz (per col. 2, line 41). ***The high pass filters themselves (i.e., 3, 3', 30, 30') are used to suppress these interference signals of low frequency received by the microphones*** (emphasis added)."[44] Appellants respectfully disagree for the reasons discussed below.

Arndt is directed to a hearing aid device having a directional microphone characteristic produced by at least two microphones of the same type the deviate from one another in their signal transmission behavior.

Arndt teaches, "[m]icrophones customarily used in hearing aid devices nowadays represent acoustic high-pass filters in their signal transmission behavior."[45] Thus, the signal transmission behavior of microphones <u>in hearing aid devices</u> mimics the signal transmission behavior of acoustic high-pass filters.

Comparing the microphones in hearing aid devices to acoustic high-pass filters, Arndt teaches that "[t]he limit frequency of such a high-pass filter, i.e. the frequency at which the magnitude of the output signal divided by the magnitude of the input signal equals -3dB, is about 100Hz. To reach this limit frequency, <u>each of the microphones</u> used has a small hole in its membrane, causing the limit frequency—dependent on the diameter of this hole in the

[43] Action, p. 3.
[44] Action, p. 5.
[45] Arndt, col. 2, ll. 37-39.

membrane—to be shifted to higher values."[46] Therefore, the small hole in the membrane of the microphone causes the limit frequency to shift.

Furthermore, "[t]his shift is necessary to suppress interference signals of lower frequency, as occur in a car, for example, which otherwise could easily lead to over amplification in the hearing aid device."[47] In other words, the shift in the limit frequency caused by the small hole in the membrane of the microphone suppresses the lower frequency interference signals. That is, the function of the small hole in the membrane of the microphone is to suppress the lower frequency interference signals.

Accordingly, referring to FIG. 2 (reproduced below), the lower frequency interference signals traveling through the microphone equivalent circuit are suppressed prior to reaching the high-pass filters 30 and '30.

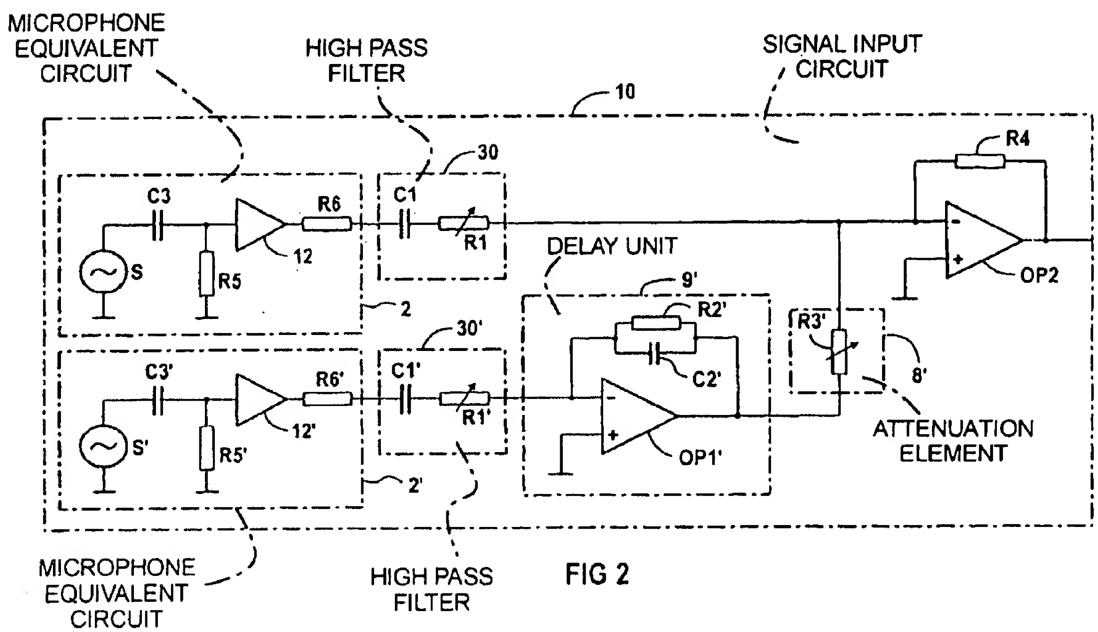

FIG. 2 OF ARNDT

For instance, Arndt teaches that "[i]n accordance with the invention the two high-pass filters 30 and 30' are matched in their limit frequencies to the limit frequencies of the preceding microphones in contrast to known circuits."[48]

[46] Arndt, col. 2, ll. 39-46 (emphasis added).
[47] Arndt, col. 2, ll. 46-49 (emphasis added).
[48] Arndt, col. 4, ll. 40-43 (emphasis added).

Arndt further teaches that "[f]or this purpose, in the exemplary embodiment, the values of the programmable resistors R1 and R1' are selected such that the limit frequency of the microphone 2 corresponds to the limit frequency of the high-pass filter 30' and the limit frequency of the microphone 2' corresponds to the limit frequency of the high-pass filter 30. Thus, in a simple manner, it is possible to balance manufacturing related variation of the limit frequencies of the microphones used."[49] In other words, the resistor R1 of high-pass filter 30, which correspond to the first microphone 2, is selected to match the limit frequency of the second microphone 2'. Thus, the function of the high-pass filters 30 and 30' is to respectively match the limit frequencies of the other microphone in order to control the amplitude response and/or phase response (*i.e.*, the directivity pattern) of the two microphones, not to prevent low frequency components from reaching a sigma-delta modulator, as claimed in independent claim 1. See Arndt's Abstract.

As such, Appellants maintain that Arndt fails to teach, or suggest, "the filter means preventing low frequency components from reaching the sigma-delta modulator" as recited in independent claim 1.

Furthermore, even assuming *arguendo* that the hole in the membrane of the microphone did not exist, Appellants submit that the limit frequency of the high-pass filters would not match the limit frequency of the microphone. Thus, the modification would disrupt Arndt's attempt to balance the variation of the limit frequencies of the two microphones 2 and 2', and accordingly, defeat the intended purpose of Arndt's hearing aid.

Appellants submit that "[i]f proposed modification would render the prior art invention being modified unsatisfactory for its intended purpose, then there is no suggestion or motivation to make the proposed modification. In re Gordon, 733 F.2d 900, 221 USPQ 1125 (Fed. Cir. 1984)..."[50] Accordingly, Appellants submit that the Examiner has not established a proper *prima facie* case of obviousness.

ii. Position of Arndt's High-Pass Filters

In addition to above, Appellants submit that Arndt teaches that the two microphones 2 or 2' each are illustrated by a microphone equivalent circuit, as shown above in FIG. 2 of Arndt. Appellants note that the high-pass filters 30 and 30' are positioned outside of the

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[49] Arndt, col. 4, ll. 43-51.
[50] MPEP §2143.01(V).

microphone equivalent circuits 2 and 2' as indicated by the dashing line surrounding elements S, C3, R5, R6 and 12.

Thus, contrary to the Examiner's assertion, Appellants submit that the Arndt also fails to teach, or suggest, a microphone assembly comprising a filter means as recited in independent claim 1.

iii. Lack of Motivation to Combine Martin and Arndt

As discussed above, Appellants submit that the function of the high-pass filters 30 and 30' of Arndt is to respectively match the limit frequencies of the other microphone for amplitude response and/or phase response of the two microphones.

However, Appellants submit that Martin discloses a digital hearing aid with <u>one</u> microphone. Therefore, Appellants submit that one of ordinary skill in the art would not be motivated to combine Arndt's high-pass filters, which are intended to match the limit frequencies of <u>two</u> microphones in a directional hearing aid, with Martin's digital hearing aid, which includes only <u>one</u> microphone. Including an adjustable high-pass filter in Martin's digital hearing aid would serve no useful purpose because there is no second microphone to which the amplitude response and/or phase response of the existing microphone must be matched.

Absent inappropriate hindsight guided solely by the Appellants' disclosure, Appellants submit that Martin and Arndt fail to motivate one of ordinary skill in the art to provide a filter means, as taught by Arndt, between the preamplifier 8 and the A/D converter 7 in the microphone housing 6 taught by Martin. As such, Appellants submit that the combination of Martin and Arndt is improper.

For at least the reasons discussed above, Appellants submit that Arndt fails to cure the deficiencies of Martin with respect to independent claim 1. Accordingly, even assuming *arguendo* that the references could be combined (which is not admitted for the reasons previously expressed) Martin in view of Arndt would still fail to teach, or suggest, a microphone assembly including a "filter means in the signal path between the pre-amplifier and the sigma-delta modulator, the filter means preventing low frequency components from reaching the sigma-delta modulator" as recited in independent claim 1.

VIII. CONCLUSION

Appellants respectfully request that the Board reverse the Examiner's obviousness rejection of claims 1, 5, 7, 17, 18, 36 and 38 in view of Martin and Arndt.

The Commissioner is authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 08-0750 for any additional fees required under 37 C.F.R. § 1.16 or under 37 C.F.R. § 1.17; particularly, extension of time fees.

Respectfully submitted,

HARNESS, DICKEY, & PIERCE, P.L.C.

By:________________________________

John A. Castellano, Reg. No. 35,094

P.O. Box 8910
Reston, Virginia 20195
(703) 668-8000

JAC/CDW

Attachments: IX. Claims Appendix
IIX. Evidence Appendix
IIIX. Related Proceeding Appendix

IX. CLAIMS APPENDIX

1. A microphone assembly comprising

- a microphone assembly casing having a sound inlet port,
- a transducer for receiving acoustic waves through the sound inlet port, and for converting received acoustic waves to analog audio signals, said transducer being positioned within the microphone assembly casing,
- an electronic circuit positioned within the microphone assembly casing, said electronic circuit comprising a signal path defined by a cascade of
  - a pre-amplifier for amplifying analog audio signals from the transducer, and
  - a sigma-delta modulator for providing digital audio signals,

wherein the microphone assembly further comprises filter means in the signal path between the pre-amplifier and the sigma-delta modulator, the filter means preventing low frequency components from reaching the sigma-delta modulator.

5. A microphone assembly according to claim 1, wherein the filter means is a high-pass filter.

7. A microphone assembly according to claim 1, wherein the pre-amplifier, the sigma-delta modulator, and at least part of the filter means are integrated on a chip so as to form a monolithic integrated circuit.

17. A portable unit comprising

- a microphone assembly according to claim 1, said microphone assembly being connected to a pure digital signal processor for further signal processing.

18. A portable unit according to claim 17, wherein the portable unit is selected from the group consisting of hearing aids, assistive listening devices, mobile recording units, such as MP3 players; and mobile communication units, such as mobile or cellular phones.

36. A microphone assembly according to claim 1, wherein the filter means is a band-pass filter.

38. A microphone assembly according to claim 5, wherein the amplifier forms part of a monolithic integrated circuit further comprising the pre-amplifier, at least part of the filter means and the sigma-delta modulator.

IIX. EVIDENCE APPENDIX

NONE

IIIX. RELATED PROCEEDINGS APPENDIX

NONE